# CARNIVOROUS PLANT NEWSLETTER

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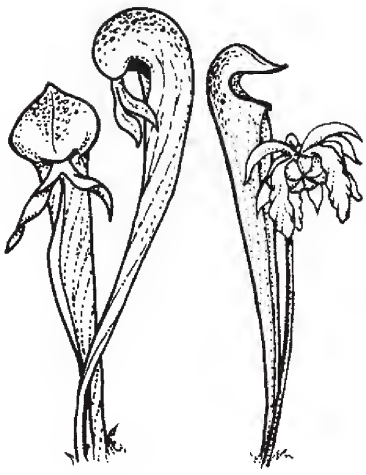

# CARNIVOROUS PLANT NEWSLETTER

**Journal of the International Carnivorous Plant Society**
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**Volume 45, Number 1**
**March 2016**

**Front Cover: The beautiful flower of *Utricularia* 'Brazilian Beauty'. Photo by Greg Bourke. Article on page 33.**

Carnivorous Plant Newsletter is dedicated to spreading knowledge and news related to carnivorous plants. Reader contributions are essential for this mission to be successful. Do not hesitate to contact the editors with information about your plants, conservation projects, field trips, or noteworthy events. Advertisers should contact the editors. Views expressed in this publication are those of the authors, not the editorial staff.

All correspondence regarding dues, address changes and missing issues should be sent to the Membership Coordinator at the ICPS. Do not send such correspondence to the editors. Checks for subscriptions should be made to the International Carnivorous Plant Society in US funds. Dues, including a subscription, are $30 per year.

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## Erratum

According to information received from Alastair Robinson, scientific editor at Redfern Natural History Productions, Ltd., the publisher of Allen Lowrie's monumental "Carnivorous Plants of Australia, Magnum Opus" (see Carniv. Pl. Newslett. 44: 120-145 & 164-166, 2015), volume 3 that contains the descriptions of all new taxa recognized in this work was published effectively after *19 March 2014*, in contrast to "16 December 2013" as printed in the book itself and reported in the two papers cited above. (JS)

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# 11TH INTERNATIONAL CARNIVOROUS PLANT SOCIETY CONFERENCE 2016

LONDON, ENGLAND

5-7 August 2016

The 11th ICPS Conference will be held at Royal Botanic Gardens, Kew 5-7 August 2016.

To coincide with the ICPS Conference, Royal Botanical Gardens, Kew is planning to host a Science Festival, which will have carnivorous plants as a major theme. The Carnivorous Plant Society (The CPS) understand that the Science Festival will run from 4-7 August 2016.

## Conference Delegates

An extensive lecture programme will be available for Conference delegates, which will run across the 3 days with a similar number of presentations to the 2014 ICPS Conference held in Cains, Australia. We are also looking at the possibility of an extra lecture on the evening of 4th August for those arriving early. Opportunities to explore behind the scenes at RBG, Kew are also being arranged, such as the RBG, Kew Herbarium and private carnivorous plant collections – most notably *Nepenthes*.

On the 8th we are planning to visit Down House, travelling by coach from Kew. If it can be arranged we will also take an afternoon visit to Keston Bog, a short drive from Down House, where Darwin collected many of the *Drosera rotundifolia* he studied. Sadly *D. rotundifolia* has long since perished at the site due to drainage and shrubs/trees moving in, but the CPS is participating in preparing plans to improve the bog and to reintroduce the plant.

There will also be a field trip to the New Forest and Dorset, planned for 9th-11th August (includes travel from London early morning on 9th and returning late afternoon to London on 11th). This part of Britain and Ireland is a hotbed for our carnivorous plant species, including *D. rotundifolia, D. intermedia*, *D. anglica*, *D.* × *eloisiana*, *D.* × *obovata*, *U. minor, U. bremii*, *U. australis*, *U. stygia*, *U. intermedia*, *P. lusitanica* and a variety of non-native North American Pitcher Plants (mainly *S. purpurea* subsp. *purpurea* and *S. purpurea* subsp. *purpurea* f. *heterophylla*). At this time of year we would expect *U. minor* and *U. stygia* to be in flower. *U. australis* is in flower from early July, and provided there isn't heavy rain between the end of flowering and the field trip then it is possible to still see the odd flower (no promises!). We were hoping to see *Dionaea muscipula* too, but unfortunately it has been recently removed.

Most of the sites we will visit are designated Sites of Special Scientific Interest (SSSIs) and have other botanical interests, including orchids. We are hoping to have along the local ecological recorder for the Dorset leg of the field trip to point out the additional curiosities.

These would be an additional cost to the Conference fee (all TBA). Priority for the seats available on both trips will be given to Conference Delegates.

The field trip leaders will be myself (Tim Bailey) and Dennis Balsdon. I've had the pleasure to study the sites we will visit for the last few years and each location will provide plenty to see. Time willing, we may also have time for an ice cream at the National Trust, Studland Bay, Poole harbour, centre. As we cool off taking in the stunning beach environment.

As delegates attending the field trip might also want to visit Down House, the start of the field trip is delayed until the 9th.

## Non-Conference Attendees

The Conference lecture programme and other Conference benefits will not be available to Non-Conference attendees. However, a plant sales and display area, the Science Festival, public CP lec-

tures, etc., and of course all else RBG, Kew has to offer, would be available as part of Kew ticket pricing. We are working with Kew to provide a 4-day pass for the duration of the Conference and proposed Science Festival to reduce cost.

Conference delegates would be able to enjoy these at no extra cost.

## CP Sales and Displays

An extensive CP sellers/display area is planned to be open for the duration of the Conference and Science Festival. Those interested in participating in the CP sales area at the Conference and/or to put on a CP display are encouraged to contact The CPS at the earliest time.

The CPS will be putting on two displays. A traditional show stand of genera/species from around the world and a stand exhibiting carnivorous plants from our sustainable and peat-free cultivation research programme.

## Conference Meal

Following on with tradition we will be hosting an evening meal (fee TBA) at a restaurant local to RBG, Kew. We have provisionally and exclusively booked an Italian restaurant (ASKITALIAN): http://www.askitalian.co.uk/restaurant/kew/ ASKITALIAN will cater for any special food requirements.

## Travel Advice

Planning will be on everyone's mind, so if you are looking into this please make sure to check out this: http://www.kew.org/visit-kew-gardens/plan-your-visit/getting-here

International attendees will need to review connections from major London airports: http://www.visitlondon.com/traveller-information/travel-to-london/airport?ref=nav

## Need to Know More

As we progress towards the Conference more information will be posted on our website, including suggestions of places to stay. To help ensure nothing is missed we will post a link on the various Forums, Facebook, etc., when the site is updated.

## Need to Contact Us

The CPS Website: http://thecps.org.uk/

General Enquires: http://www.thecps.org.uk/contact.php

CP Seller/Display: Direct to Mitch Raymond at MBRaymond@googlemail.com

We will keep you updated on the conference and hope you are as excited as we are about holding it, if you have any questions please let us know.

Tim Bailey, Chairman
On behalf of The CPS Committee

# The IUCN Carnivorous Plant Specialist Group

The International Union for the Conservation of Nature (IUCN), is an international organization aimed at the protection of nature in a broad sense. It is made up by more than 1200 governments and nature organizations from all over the world and has a staff of about 1000 employees and over 11,000 volunteer scientists and specialists in more than 60 countries. The IUCN is best known for the Red List of threatened species that it maintains and that is used by many governments as a foundation of their conservation policy.

To achieve its goals, the IUCN is made up by several committees, one of them being the Species Survival Committee (SSC) that is aimed specifically at the IUCN work into threatened and endangered species. To help this committee several so called "Specialist groups" have been set up. These are groups of volunteer scientists and experts in a certain group of plants or animals that use this organizational construction to work together and provide the SSC with the necessary information on their chosen subject.

The Carnivorous Plant Specialist Group (CPSG) is one of those groups of volunteers. This group has a very special relation with the ICPS and not only by its chosen specialism. That is why I would like to take this time to tell you a little bit about the group and this relation.

In the past there had been a carnivorous plant group, but for several reasons that was disbanded long ago. However, at the 2010 ICPS Conference held in Leiden, a discussion was held as the closing session of the conference on what could be done to improve current policy and conservation activities at a larger scale. Individuals and even societies could not accomplish the changes that were deemed necessary by themselves. As a result, the idea was born to bring back a carnivorous plant group within the IUCN structure. Such things take time, but in 2012 the first directed efforts resulted in a rebirth on paper. After this, things went better at the 2014 ICPS Conference in Cairns and the CPSG was proudly introduced to the world.

The CPSG has started out very successfully. Chaired by Robert Cantley, it was decided that its first goal should be to make accurate assessments of the conservation status of all carnivorous plants. That this is a monumental task every one of us can imagine. With over 750 different species of carnivorous plants and new ones being found or split on what seems like a weekly basis, that task is huge. To make sure the assessments get properly done and submitted to the IUCN Red List unit, the group has a Red List focal point to manage this process. Dr. Charles Clarke was chosen for this challenging job.

This gave the CPSG two well-regarded specialists to form the core of the group, with the CPSG getting some impressive results. Its first major coup was to get a patron. Most specialists groups do not have a famous patron, which puts them at a disadvantage in an arena with a battlefield laid out by science, politics, and public opinion. Not so the CPSG. Not only did they manage to get a patron, they managed to get THE PATRON! No one less than Sir David Attenborough agreed to become patron to the CPSG.

As for his reasons, Sir David can very much better put that to words than I ever could, so I have attached the letter of introduction he wrote for the CPSG website.

In 2014, the CPSG made its first strong impression on the IUCN-SSC. No less than 60 species of *Nepenthes* were assessed and submitted. Also drafts of several species of *Drosera* were completed.

In 2015, the CPSG website got reinforced with two Facebook pages, one set up as an information page and one as a discussion group were people can interact with the CPSG Specialists and Members (Web addresses below this article).

These pages, run by Andrew Broome, Michael Schöner, and myself, managed to get a reasonable amount of attention and also scored the CPSG some points with the SSC. This, and the skill of its chair, resulted in two major successes in September 2015.

First of all, the genus *Utricularia* had always been the domain of the specialist group dealing with aquatic plants. In a SSC meeting last September, it was decided that *Utricularia* should go to their real home, the carnivorous family of the CPSG.

The value of the second success can't be overstated. It was decided to give the CPSG a huge boost to achieve its goals by giving it the support of the IUCN professionals for a fundraising campaign in November and December 2015. Basically, a 6-week professional fundraising campaign was set up with donation page, bulk e-mail to contacts, and interesting facts and blogs being send into the world using the fast IUCN resources.

It was estimated that $125,000 will be needed to assess all species of carnivorous plants: to collect information, to cover expenses of the unpaid volunteers making the assessments, and, if necessary, go into the field to get the information that is lacking.

The goal of the 6-week funding campaign was to raise $25,000 of this amount to conduct a first 5-day-long workshop with a group of selected Specialists to assess as many species as possible. Hopefully, initial assessments of all species can be done, resulting in a clear list of so called "data deficient" species that will direct where to spend the remaining funds and concentrate the efforts to get more data.

This workshop brings me to another special relation of the CPSG with the ICPS. The workshop is to be held the week before the 2016 ICPS Conference in Kew, London, England. It is hoped that Conference attendees can be given an impression of the Red List process in action and that the preliminary results of the workshop can be presented at the ICPS Conference.

As I'm writing this, the fund raiser is still in full swing. I don't know if we are going to make the $25,000 goal by December 31st, but that date is just the date when the IUCN professionals get reassigned to another job. We have more time to reach this goal so the donation option will remain open and of course there is that overall goal of $125,000 to reach over a longer period of time.

The ICPS is of course in full support of this financial goal. Therefore, the ICPS Board decided to donate an initial $5,000 to this effort. Other societies, companies, and private individuals are also donating and I would like to encourage everyone capable of making a donation to do so.

Assessing the conservation status of all carnivorous plant species is an important tool to decide how to focus conservation efforts and regulations.

It will provide a real-time reality check to politicians and collectors alike about the plants that are in their care and that we love so much.

Marcel van den Broek
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Facebook discussion group: https://www.facebook.com/groups/1462966880625521/

## Sir David Attenborough's introduction letter for the CPSG website

Carnivorous plants fascinate a wide public. And understandably so. They seem to defy all conventional preconceptions about plants in the way they move, the organs they develop, and the way they sustain themselves. One consequence, however, is that many of the species are now seriously threatened by poaching. A number have such localised distribution that a single unscrupulous collector could exterminate them in the wild. Some species inhabit only the most fragile of ecosystems, such as a single mossy ridge or a mountain summit. So ongoing degradation of habitat is also a major threat.

The cumulative result of all these factors has been an alarming decline in populations of many carnivorous plants. Some species are at risk of extinction, even as they are being recorded for the very first time. Yet there is much still to learn about them – about how many species exist, the physiological processes on which they depend, and the relationships they have with animals – not only their insect prey but even mammals, with which they sometimes have unique relationships.

It is thus excellent news that the IUCN Species Survival Commission has now set up a Specialist Group to study and help preserve these amazing plants, not only in the wild but also in cultivation. The work of this new Specialist Group in providing accurate and up-to-date IUCN Red List conservation assessments for all carnivorous plants will be an invaluable tool for research scientists and conservationists around the globe. It will also co-ordinate ongoing conservation initiatives and facilitate partnerships between *in-situ* and *ex-situ* conservation projects. This will even include investigating such exciting possibilities as taking *ex-situ* stock of species that have become extinct in the wild and reintroducing them into their original habitat. It will also aim to encourage everyone to understand and enjoy these unique plants.

The Carnivorous Plant Specialist Group consists of a worldwide group of experts who volunteer their time and knowledge to attain these goals. I am proud indeed to become its Patron.

*David Attenborough*
Broadcaster and Naturalist

# In memory of Steven David Rose
16 January 1950 - 12 June 2015

Allen Lowrie • Western Australia • allen.lowrie@bigpond.com

Steve Rose was raised in Bedford Park, a suburb of Perth, Western Australia. He lived opposite the well-missed Phill Mann. As kids they played together in the local swamplands catching frogs and tadpoles as well as admiring the vast number of flora species that abounded in those areas. Through adventures and scuffles, they remained good friends throughout life.

Steve was a keen collector and grower of Australian terrestrial orchids. I first met him at the local orchid society in our teens. With our mutual friend Robert Oliver, we undertook numerous orchid hunts in the bush lands that surrounded Perth. Sharing our collections and growing knowledge with any spare time we had.

Steve Rose with *Byblis lamellata* at Eneabba, Western Australia in 1980.

As the years went by Steve married Lesley and as a true visionary, lived what we now call "a sustainable lifestyle". They moved to northern Queensland living in sustainable communities before returning to Perth to live in an early settler's house on a vineyard in Guilford with Lesley and his daughters Vanessa and Rachael. This is where he built his first greenhouse to house his rapidly growing collection of native terrestrial orchids and beloved Australian carnivorous plants. He and Lesley ran a business growing native plant tube lines that were sold onto nurseries in Perth.

During this time Steve wrote a report that was published in 1973 (CPN vol. 11, no 2, June 1973) when the journal was a humble typewriter set newsletter. He recorded his observations of *Cephalotus* in the wild. Later, Steve focused his research on his passion for pygmy *Drosera*. He can be attributed to many new discoveries about these little gems. It is at this time in the 70's that Steve and I reconnected and began a long friendship based on our shared passion for carnivorous plants, native flora and fauna, and gold prospecting.

Being a little older and now owning cars that were not "old bangers", we ventured further afield throughout south west Western Australia. Exploring valleys, slopes, and summits, we drove at walking pace and stopped at each change in soil type. Steve's botanical method was to walk in a semicircle out and back to the road side as I did the same on the opposite side of the road. We covered a lot of ground with this surveying method and discovered many new species of carnivorous plants such as pygmy and tuberous *Drosera*.

Through our observations of soil typography, we would soon establish a growing knowledge that a particular soil or mixed soil type such as laterite or white silica sand soils or the mixes of the two

soil types and its aspect in relationship to whether it was a valley (wetter soils) or summits (dryer soils) or the slopes between (seasonal watersheds experiencing both a sometime wet sometime dry soils) was the key to a particular species preferred habitat. After many years of this survey work, we could both assess what species should be found in a particular area based on the soil type and the position in the landscape.

Steve's inventive mind and powers of observation established a formula to select the right soil types to use when growing carnivorous plants and terrestrial orchids in cultivation. His propagation skills were second to none and established methods to propagate *Cephalotus* plants and pygmy *Drosera* from leaf cuttings.

Steve also grew *Sarracenia* from seed to flower in 18 months. He used lights to extend the day light hours but also kept the pitchers full to the brim with liquid fertilizer applied to the baby pitches with a hypodermic syringe and needle and later when the pitchers were larger by syringe only.

I am grateful for the memories I have from an unforgettable expedition to Sumatra. We traveled from Padang to Lake Toba exploring mountains and roadsides along our way. We were fortunate enough to join up with the Nepenthes study husband and wife team from Canada, John Turnbull and Anne Middleton. John had selected some great locations, the highlight of which was Mount Talang, Sumatra, Aia Batumbuak, West Sumatra, Indonesia. It was on this summit where we camped for the night. Just at dusk we heard the sound of a big cat. A tiger in close proximity. We all slept with one eye open that night.

This was not the only danger we were to face. Whilst decending Mount Singgalang vulkaan in Bukittinggi (2878 m) Sumatra, Steve saved Anne's life. The downward trail was greasy with wet and clayey soils. On a steep incline, half way down the summit Anne lost her footing, fell on her back and rapidly skidded down about 30 meters. I yelled out to Steve, who was leading, to grab Anne. He saved her just before she was going over a long-drop cliff face beside the trail. Steve saved Anne's life. It was only after we realized that the cliff wasn't the only thing that could have killed her. As she was carrying a large jungle knife (a bolo) on her back and was lucky that the knife did not find its way into her body as she skidded towards Steve.

The adventures for Steve were just beginning. It was about this time Steve was also getting very interested in the idea of gold prospecting. He recalled tales from his grandfather who was also a gold prospector at the turn of the century. He said he was going to buy one of these new metal detecting machines and try to find gold. I'm sorry to recall that our friend Rob Oliver and I thought this gold quest was nuts! We were soon to eat our words. In 1980 when I was visiting our friend Rob Oliver in California, there on the 60 Minutes show was Steve, Lesley, and his daughters showing the reporter all the gold they had found with their metal detectors. It turns out he was not nuts; he had found gold and lots of it.

Steve and his family soon moved to Kalgoorlie where they continued gold prospecting. Steve made some very good gold discoveries and did business with larger mining companies. He was a self-taught geologist and with his skills recognized he became a professional prospector and was hired to conduct gold surveys between Kalgoorlie and Hopetoun. Principally prospecting in the no man's land region of Forrestania.

Steve's prospecting career took him to the highlands of Papua New Guinea while prospecting for an American mining company. Steve told me this entailed being lowered by helicopter into the jungle where he would gather rock samples and complete area surveys. During these adventures into prospecting, Steve was never far away from his love of plants. He collected New Guinea *Impatiens* seed for Rob Oliver and *Nepenthes* seed for Phill Mann. Steve's prospecting career also took him to China and parts of SE Asia.

Steve was a man with a brilliant mind. As an inventor, he could trouble shoot and engineer all manner of mechanical and electronic machinery. For example, our early Garret metal detectors were awkwardly heavy, and prone for misreading signals, despite being the best in the market in the 1980's. Steve invented a solution by relocating the heavy electronics box to a waist belt position thus reducing the weight of the metal detector and positioning all of the equipment components in a more ergonomic way. He also added a 10-turn Vernier dial modification to the ground-canceling potentiometer to better cope with ground-mineralization signal changes.

Another great life moment afforded to me by Steve was when he invited Rob and me up to the gold fields to have a go at gold detecting for ourselves. With Rob prospecting away in the distance, I took the opportunity to "commune with nature". As I made my way back to Rob's location with detector waving, I managed to unearth a 2/3 of an ounce gold nugget within two paces. As nature calls as they say…Eureka!

I was hooked. Steve and I later became partners in a number of gold tenements and at one stage we owned the tenement known as Webb's Patch near Cue. We found a lot of gold on those tenements and had a lot of good times.

Steve's passing is a sad loss to the horticultural (especially the orchid and carnivorous plant) enthusiasts and the gold mining communities of the world. He will be missed but he will always be remembered by those that knew him closely that he was a great guy and it was a pleasure to be part of his life. Catch you later mate.

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# Niche partitioning in sympatric *Sarracenia* species at Splinter Hill Bog Preserve, Baldwin County, Alabama

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Keywords: Ecology, *Sarracenia*, Splinter Hill Bog Preserve, Alabama.

Abstract: With anthropogenic influences limiting and fractioning wetlands, it is imperative to understand niche partitioning in keystone species. *Sarracenia* (Sarraceniaceae), a genus of carnivorous plants, are ecologically important species found in wetlands along the eastern coast of the United States. Species diversity of this genus is highest in the southeast, particularly along the Gulf Coast where they are found primarily in longleaf pine savannas. This study aims to identify underlying causes driving niche partitioning, specifically exploring water table elevation and soil type as potential sources. Splinter Hill Bog Preserve, located in northeastern Baldwin County, Alabama, served as the study site for this work. Findings indicated small, but significant correlations between soil type and species distribution, as well as between soil type and water table elevation.

## Introduction

Niche partitioning has been informally documented in sympatric species of North American pitcher plants, *Sarracenia* (Sarraceniaceae), over the last several decades. Niche partitioning is the process by which natural selection acts upon organisms and allows closely related species to inhabit different environments or microenvironments. Although many reports allude to obvious habitat differences (shade, soil moisture, *etc.*) to explain distribution of species in sympatric *Sarracenia* populations (McDaniel 1966; Gibson 1983; Schnell 2002; Mellichamp 2009), few empirical studies have evaluated the underlying factors driving niche partitioning among species.

Eleven species (*S. leucophylla*, *S. purpurea*, *S. psittacina*, *S. rubra*, *S. flava*, *S. alata, S. oreophila*, *S. minor*, *S. alabamensis*, *S. jonesii*, and *S. rosea*) and several subspecies and varieties of *Sarracenia* are currently recognized (Ellison *et al.* 2012). One species, *S. purpurea*, radiates up the east coast, across the northern U.S. and boreal Canada west to British Columbia (Sheridan 2010). In the southeastern U.S. (Florida, Georgia, Alabama, Mississippi, and Louisiana), where *Sarracenia* species are found in sympatry, hybridization is common (Furches *et al.* 2013) and niche partitioning is prevalent (pers. obs., JSH).

Closely related sympatric species may still have slight differences in microenvironment requirements (e.g. salinity, elevation, pH, *etc.*; Welch & Rieseberg 2002). These differences are not only important for a species' ability to expand its range and to compete for resources, but they can also be important from an evolutionary perspective. If hybrids are able to utilize adaptations from parent species and potentially occupy habitats that are not optimal to either parent species, there is increased opportunity for spatial isolation that could promote speciation over time (Arnold *et al.* 1991; Edwards-Burke *et al.* 1997; Milne *et al.* 1999).

Soil characteristics have been shown to influence wetland plant species composition in pitcher plants bogs in the Little River Canyon National Preserve in Alabama (Carter *et al.* 2006). The unique geology and hydrology of bogs, in particular southern pitcher plant bogs, may be the underlying cause of observed niche partitioning in sympatric *Sarracenia* species. Southern pitcher plant bogs are typically made up of sandy soils, with the water table just below or at ground surface level. In some cases, shallow clay layers (i.e., aquicludes) that allow water to accumulate may cause local areas of saturation in places with deeper water tables (Plummer *et al.* 2001). These aquicludes, as well as other hydrological and geological influences (e.g., water-table elevation, soil types, *etc.*), may be sources of variation in plant species distribution in a seemingly homogenous habitat.

The most extensive study of distribution patterns in *Sarracenia* (and other carnivorous plants) was by Gibson (1983), who proposed there would be negative associations between species of similar heights, as more pitchers at the same height increases competition for insect prey. Although *Sarracenia* species use passive traps to capture prey and are not specialized for any particular prey type (Ellison *et al.* 2009), intra- and interspecific competition still exists (Gibson 1983). Previous work indicated that competitive avoidance resulted in distribution of carnivorous plants by height. However, these findings do not address the potential role of hydrology and soils in niche partitioning among sympatric *Sarracenia*.

With continuously decreasing habitat available for *Sarracenia*, studying the relationships between species distributions and microenvironment is more important than ever for conservation efforts. The objective of this study was to determine the role of hydrogeology and soil classification in driving *Sarracenia* species distributions within the same relatively small geographic area. The hypothesis was that species would be differentially distributed as a result of adaptations to different soil types or water table depths.

## Materials & Methods

### Study site

Splinter Hill Bog Preserve (SHBP) in Baldwin County, Alabama, which is owned and managed by The Nature Conservancy, was the focus of this research. This location was chosen because it is home to six of the eleven described *Sarracenia* species: *S. flava*, *S. rubra* subsp. *wherryi*, *S. leucophylla*, *S. psittacina*, and *S. rosea*. This diversity made it an ideal location to study sympatry and niche partitioning within native communities (Fig. 1). In 2009, three plots were established on a restored longleaf pine savanna within SHBP (Fig. 2). These savannas are naturally prone to low intensity fires, which aid in nutrient cycling, eradication of non-native species, and promote seed germination for some of the native plants. The sampled savanna was clear-cut in 1996, and at the time our work was completed was annually burned to manage encroachment of woody and invasive species. An old dirt logging road, now used as a hiking trail, splits the savanna site down the center from north to south. Based on observations at the time of sampling, *Sarracenia leucophylla* was evenly distributed throughout this location, while *S. rosea* was found more frequently on the east side of the hiking trail, with fewer individuals near the hiking trail on the west side. *Sarracenia psittacina* was more narrowly distributed on the east side of the trail near the edge of the woods where the soil is more saturated. Putative *S. leucophylla* × *rosea* hybrids were found mainly on the east side of the trail, but were also found infrequently throughout the west side of the trail, where there were no *S. rosea* individuals observed.

SHBP is underlain by the Citronelle Formation (USDA 1964). This formation is of Pliocene age (5.3 to 2.6 Mya; Walker & Geissman 2009), and lies above the Hattiesburg Clay and older forma-

Figure 1: *Sarracenia* species and putative hybrids observed in this study at Splinter Hill Bog, Baldwin County, Alabama, USA. *Sarracenia leucophylla* (top left), *S. rosea* (top right), and putative hybrids (bottom left and right). *Sarracenia psittacina* (not pictured) was present but infrequent in sampled areas.

tions. The Citronelle Formation, consisting primarily of sand, clay, and gravel, is gently sloping towards the Gulf of Mexico. In the SHBP area, elevation typically ranges from 60 to 80 m above sea level. The elevation of SHBP's savanna site ranges from 70 - 60 m above sea level from west to east, with Dyas Creek forming the eastern perimeter. Soil in this area is predominantly sand with

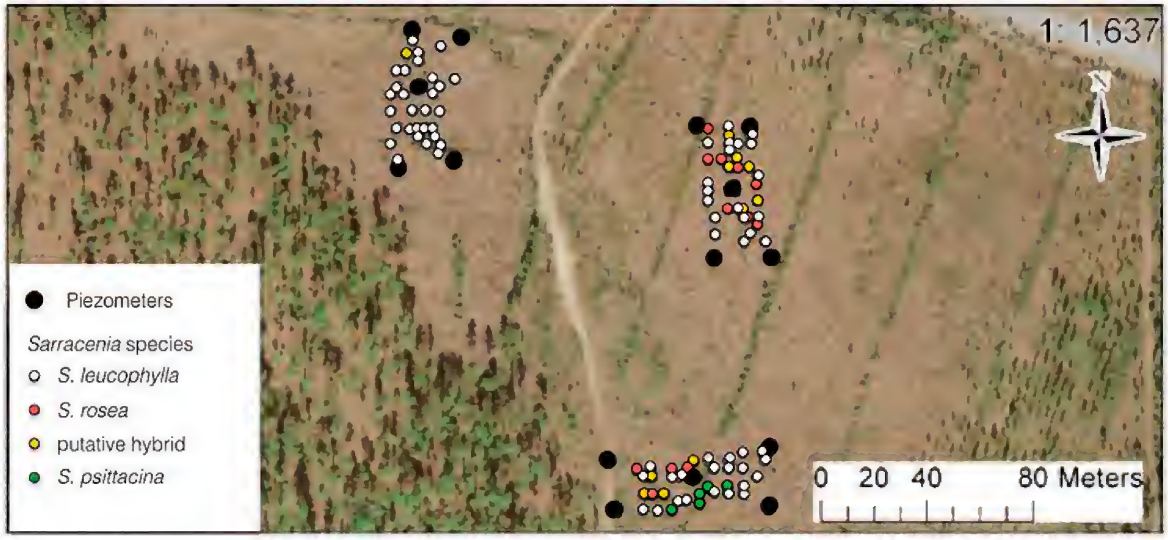


Figure 2: Aerial photo of Splinter Hill Bog Preserve showing plots sampled in the present study. Black circles represent piezometer locations and colored circles represent *Sarracenia* species sampled (white = *S. leucophylla*; red = *S. rosea*; yellow = putative *S. leucophylla* × *rosea* hybrid; and green = *S. psittacina*).

thin layers of clay. All soils are hydric, meaning there is saturation, flooding, or ponding for all or part of a growing season.

Data collection

Three plots were established on a restored longleaf pine savanna at SHBP species identification and mapping (Fig. 2). Approximate distances were measured from the center of one plot to the center of another in ArcMap 10.1 (ESRI). Plots 1 and 2 were approximately 155 m apart, plots 1 and 3 were approximately 125 m apart, and plots 2 and 3 were approximately 215 m apart. Each plot was 50 m × 20 m. Within each plot, four parallel transects were established 5 m apart. Species were recorded every 5 m along each transect, for a total of nine data points per transect and 36 data points per plot (Fig. 2). *Sarracenia* species were identified at each data point along each transect (if no plant was present, the closest *Sarracenia* was sampled), such that a maximum of 36 individual plants were sampled within each plot for a total of 108 individual plants over three plots. Species were identified using the taxonomy of Schnell (1998) and Naczi *et al.* (1999), permanently numbered with aluminum tags, and documented using digital photography.

Soil core samples were obtained from each corner and the center of each study plot (five cores per plot, 15 cores across all three plots). Approximately 30 - 60 cm of core was obtained using a direct push corer. Core samples were analyzed and classified according to the Unified Soil Classification System (ASTM Standard 2006). Piezometers were placed in each of the core holes to map water table elevation (i.e., piezometric head). Depth to water table was measured three times between 2009 and 2010: first in late September 2009, second in early March 2010, and third in July 2010. Average depth to water table was calculated for each piezometer across these three dates and used to develop figures included here. Additional soil classification data, hydric soils, and elevation data were obtained from the Baldwin County Chamber of Commerce. Water table elevation was interpolated in ArcMap 10.1 (ESRI, Redlands, CA) using data obtained in the field and images from the Baldwin County Chamber of Commerce (Fig. 3).

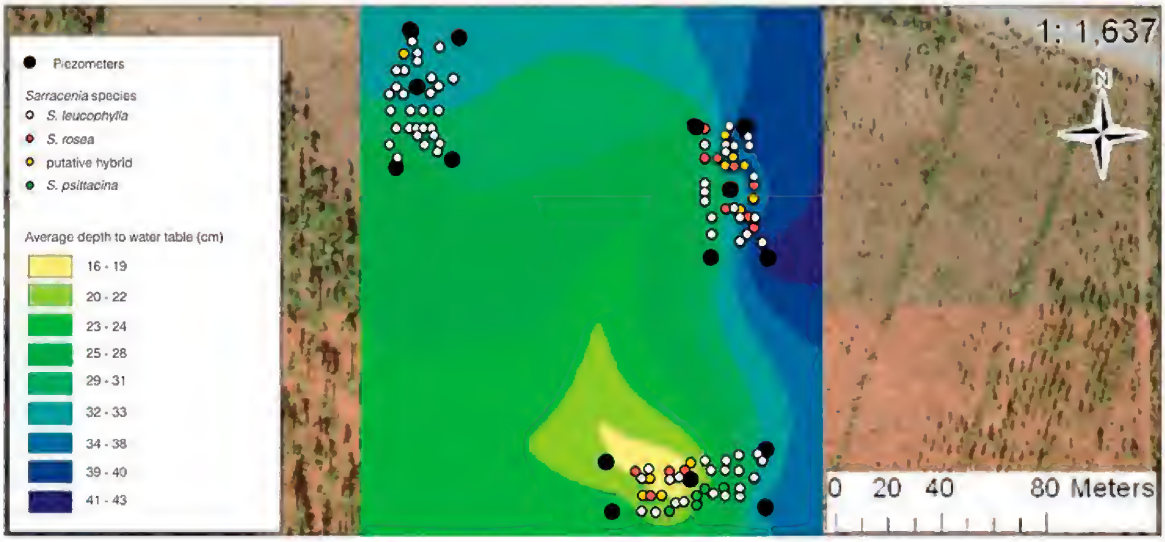


Figure 3: Average water table depths underlying sampling plots at Splinter Hill Bog Preserve. Black circles represent piezometer locations and colored circles represent *Sarracenia* species sampled (white = *S. leucophylla*; red = *S. rosea*; yellow = putative *S. leucophylla* × *rosea* hybrid; and green = *S. psittacina*). Average depth to water table (cm) is illustrated in shades of yellow (shallowest) to dark blue (deepest).

Pearson product-moment correlation coefficient (PPMCC), which measures the linear relationship of two random variables, was employed to evaluate potential correlations between species distribution, water-table elevation, and soil type. This value was determined using Minitab 15 (Minitab, Inc., State College, PA).

## Results

### Distribution of Sarracenia

Plot 1 contained twenty-one *S. leucophylla*, nine *S. rosea*, and six putative *leucophylla* × *rosea* hybrids. Plot 2 contained thirty-four *S. leucophylla* and two putative *leucophylla* × *rosea* hybrids. Plot 3 contained twenty-two *S. leucophylla*, four *S. rosea*, five *S. psittacina*, and four putative *leucophylla* × *rosea* hybrids. This pattern of species distribution observed within the sampling plots is a good representation of the species distribution in the general area, with the exception of several *S. rosea* individuals on the outskirts of Plot 2 alongside the trail, which did not fall within the parameters of the plot.

### Soils

Plot 1 and Plot 3 were in Klej loamy sand with a 0 - 5% slope. This soil type is moderately to well drained, with slow runoff and is strongly acidic in nature (USDA 1964). Plot 2 was partially in Bowie-Lakeland-Cuthbert soils with a 8 - 12% slope, and partially in Plummer loamy sand with a 0 - 5% slope. Bowie-Lakeland-Cuthbert soils are moderately to well drained with fairly rapid runoff, and are acidic to strongly acidic (USDA 1964). Plummer loamy soils are poorly drained, with slow runoff and are strongly acidic (USDA 1964). In Plot 2, only *S. leucophylla* was sampled in the Plummer portion of the plot, while both *S. leucophylla* and putative *S. leucophylla* × *rosea* hybrids were sampled in the Bowie-Lakeland-Cuthbert portion of the plot. A small, but significant correlation between soil type and species distribution was detected by PPMCC analysis across all plots ($r = -0.379$, $p = 0.000$).

Water table elevation

Average depth to water table over the three dates measured in 2009 and 2010 is summarized in Fig. 3. It ranged from 16 cm in the southern portion of the sampling area to 43 cm in the eastern-most portion of the sampling area. No significant correlation was detected between water table elevation and species distribution ($r = -0.138$, $p = 0.156$). However, correlation between water table elevation and soil type was significant, although low ($r = 0.212$, p-value = 0.028).

## Discussion

Past research has shown that competition for food (in the case of carnivorous plants) and other resources (soil nutrients, water, soil-type preference, *etc.*) are driving factors in the distribuition of closely related *Sarracenia* species of the same height within a population (Gibson 1983). Because of this competition for food, tall pitcher plant species tend to separate from other tall pitcher plant species (e.g., *S. leucophylla* and *S. flava*), but this does not explain the distribution of *Sarracenia* species at SHBP where tall, intermediate, and decumbant species are present in sympatry.

In our study, there was no statistical correlation between water table elevation and species distribution. It is important to note that water table depth varies seasonally and in response to significant rain events in these bogs. Future studies should focus on fluctuations in water table depth throughout the year and how that may relate to niche differentiation in these taxa. The fact that the correlations between soil type and water table elevation, and between soil type and species distribution, were both significant may be evidence of additional relationships between water table depth and species distribution that are yet to be uncovered.

Based on the individuals sampled here, *S. leucophylla* is most abundant and has the widest distribution at SHBP. Putative *S. leucophylla* × *rosea* hybrids seem to be widely distributed across the savanna site at SHBP similar to the putative parent species *S. leucophylla*, rather than the putative parent species *S. rosea*, which has a more restricted distribution. These putative hybrids were observed throughout SHBP, while *S. rosea* were found primarily on the east side of the hiking trail (with a few individuals on the west side closer to the trail). This distribution correlates with water table elevation, which shows *S. rosea* inhabiting areas with a higher water table, whereas the putative hybrids were found throughout. This suggests that hybrid individuals may be better adapted to some microenvironment than one of the parents, which could potentially aid in hybrid speciation. The most localized species sampled was *S. psittacina*, which is known for inhabiting more saturated areas, and is found in the lower elevations of the site where the water table is closest to the surface.

Future research involving more individuals sampled over a greater area, along with the measurement of more environmental parameters (e.g., pH, micro- and macronutrients, microbial activity) would likely yield a more accurate depiction of the influence of environmental parameters on pitcher plant distribution. Given the impacts of urbanization and habitat fragmentation on pitcher plant bogs, it is pertinent to conservation efforts to understand the driving forces of species distribution in remaining habitats, as this information would aid in restoration efforts (Groves 1993).

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# Olfactory prey attraction in *Drosera*?

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The use of scented traps for prey attraction has been reported from a few genera of carnivorous plants: most prominently in the pitcher plant genera, where a sweet honey- or fruit-like scent is detectable to the human nose from the pitchers of some populations of *Sarracenia flava*, *S. alata*, *S. rubra*, *S. oreophila*, *S. leucophylla*, and *S. minor* (Miles *et al.* 1975; Slack 1979; Juniper *et al.* 1989; Jürgens *et al.* 2009; pers. obs.), certain species of *Heliamphora* (a sweet, honey-like scent is produced from the nectar-spoons of *H. tatei*, *H. neblinae*, and *H. chimantensis*, while the pitchers of *H. sarracenioides* produce a notable chocolate-like odor when growing under natural or favorable conditions; Fleischmann & McPherson 2010), and the pitchers of some species of *Nepenthes* (e.g. *N. rafflesiana*; Moran 1996; Di Giusto *et al.* 2008). Interestingly, the Venus Flytrap *Dionaea* also has been discovered to attract prey to its traps not only by the vivid coloration, but also by producing scented volatiles (Kreuzwieser *et al.* 2014). Furthermore, a weak, musty, fungus-like fragrance is emitted from the leaves of several *Pinguicula* species such as the five species from the southeastern United States (e.g. *P. primuliflora* and *P. lutea*, pers. obs.) and *P. vallisneriifolia* (Zamora 1995), and was even generalized to be true for the whole genus (Lloyd 1942; Slack 1979). Interestingly, a large percentage of prey trapped by the sticky leaves of *Pinguicula* consists of fungus gnats (Diptera: Mycetophilidae, and Sciaridae; pers. obs.), which are attracted by this kind of flavor. Curiously, I observed that the green foliar leaves of three closely related members of *Utricularia* section *Foliosa* (*U. tricolor*, *U. tridentata*, and *U. calycifida*) also have a clearly notable, characteristic scent (which, to my nose, smells identical in these three species, and reminds me of cardamom). Since in this genus, the subterrestrial bladder traps are clearly separated from the photosynthetic organs, the scent plays no obvious role in prey attraction—perhaps it is defensive in nature? The well-known, unpleasant smell of Martyniaceae shall be just briefly mentioned here, as *Proboscidea* and *Ibicella* are evidently not considered carnivorous anymore.

The most renowned and best-studied example of a carnivorous plant with fragrant traps, however, is the dewy-pine, *Drosophyllum lusitanicum*, which produces a strong, honey-like odor from its sticky passive flypaper traps (Lloyd 1942; Slack 1979; Juniper *et al.* 1989; Bertol *et al.* 2015). The perfume produced by this carnivorous subshrub is so strong that I could first smell natural populations from the car (driving with open windows in southern Andalusia) before actually seeing the plants themselves. Likewise, even when just a single plant of *Drosophyllum* is grown in a greenhouse, it will fill the entire greenhouse space with its intense honey scent during warm, bright days.

Curiously, in *Drosera*, the largest genus of carnivorous plants with ca. 250 species, there have been almost no reports about scented traps thus far, although a few species are obviously equipped with a typical scent of their leaves, which most likely is connected to prey attraction (in combination with the visually attractive coloration of the lamina, and the glistening mucilage of the glands). Prey attraction by a combination of olfactory and visual clues has been speculated for *Drosera* as early as Darwin (1875), who states: "I suspect from the number of insects caught by the English

species of *Drosera*, and from what I have observed with some exotic species kept in my greenhouse, that the odour is attractive." Yet, surprisingly few studies focused on that topic—and those who did, examined only a single species, where they did not find a special trap scent: Jürgens *et al.* (2009) used *D. binata*, a species where I also did not observe any special scent in any of the cultivated forms I examined.

However at least in two different groups of *Drosera*, I noticed scented traps (both in cultivated specimens, as well as in plants in their natural habitat).

The first example is the volatile lemon-like scent emitted from the blood-red rosettes of *Drosera slackii* (*D.* section *Drosera*), as was observed both in cultivated specimens (originating from Palmietriver and Hermanus, South Africa) and in plants studied *in situ* at Hermanus. Curiously, I did not notice any comparable scent in any other *Drosera* I tested, not even in the closely related South African species. *Drosera slackii* catches comparatively large prey in the greenhouse, predominately large flies (mainly Muscidae), but it is not tested yet if there is a connection to the leaf scent and/or dark red coloration[1] of the species.

Secondly, I noticed odoriferous leaves in at least two "forms" of the annual plants that were all previously called "*Drosera indica*" from tropical South Africa and tropical Australia in my greenhouse; the sweet honey-like scent that is emitted from their leaves is comparable (regarding strength and fragrance) to the scented traps of *Drosophyllum*.

The South African plant, which I obtained as "*D. indica* 'large', Transvaal" from Paul Debbert, Munich, clearly belongs to *D. finlaysoniana*, following the new classification of *D.* section *Arachnopus* (the "*D. indica* complex") of Lowrie (2013). However I cannot ascertain for sure that the seeds, which I obtained from greenhouse-grown plants of Debbert in Munich in the mid-1990's, indeed originated from Africa, or perhaps from a mix-up with material from Australian or Asian provenience (thus far, I have not found herbarium evidence for an occurrence of *D. finlaysoniana* in Africa). Nevertheless, scented leaves seem to be frequent in some populations of Australian *D. finlaysoniana*, as I also grow several plants from different locations from northern Australia which display a strong, honey-like odor emitting from their leaves, filling the entire greenhouse given warm temperatures and strong sun light.

Another member of the *D. indica* complex which has scented leaves is *D. fragrans* (the very obvious sweet, honey-like scent was even the source of the species' name, see Lowrie (2013)); again, I was able to confirm the scent of the leaves this species (which is very similar to that of *D. serpens*) both in greenhouse grown plants, as well as in plants I observed near Darwin, Northern Territory, in July 2014. I did not detect any notable trap scent in the closely related, sympatrically growing *D. aquatica*, however, nor in *D. serpens* which I found co-occurring with scented *D. finlaysoniana* in the Keep River area (nor does Lowrie (2013) mention perfume for any other species of *D.* sect. *Arachnopus* than *D. fragrans*). In cultivated specimens of *D.* sect. *Arachnopus* tested, I observed trap scent only in *D. fragrans* (all specimens) and *D. finlaysoniana* (only from some locations), but not in any of the other members of that affinity.

The fact that plants of some populations of *D. finlaysoniana* have no obvious scent has no taxonomic meaning of course, and in flower scent of various (non-carnivorous) plants the same has

[1] The role of leaf coloration for prey attraction is still not clear in *Drosera*. While Jürgens *et al.* (2015) concluded that the red color of the leaves of *D. spatulata* and *D. arcturi* serves for prey attraction, Foot *et al.* (2014) found no evident connection between red trap color and prey attraction in *D. rotundifolia*. Certainly the bright red rosettes and leaves of many *Drosera* species do contrast well with the soil background of their habitats – but usually the plants are the redder the more exposed the habitat is. Some species occurring at high altitudes (e.g. above-mentioned *D. spatulata* and *D. arcturi* from New Zealand) are strikingly red in their natural alpine habitat, but have more greenish leaves at lower elevations – it is not known if they will catch significantly lower prey under such conditions. Most prey insects cannot detect colors of the red spectrum anyway, thus are more likely attracted by color contrasts than the color itself.

Figure 1: In *D. finlaysoniana*, carnivorous glands cover the leaf down to the very base (an obvious "petiole" is lacking). The small-sized prey items consisted mainly of Thysanoptera (thrips), a rather frequent small prey of other *Drosera* species with upright leaves. Keep River NP, Northern Territory, Australia.

repeatedly been observed: some populations or individuals within a given population might have floral odor, while others don't; the same holds true for sweet-honey scent in the pitchers of *Sarracenia flava* populations.

Lowrie (2013) assumed that the curious outgrowths at the leaf bases of *D. fragrans* could serve as osmophores which produce the perfume, a hypothesis that still has to be tested. In *D. finlaysoniana*, likewise strongly scented in some populations, such organs are missing (Fig. 1). Whatever the foliar source, these two annual species emit a strong, sweet, honey-like perfume, which is discernable to the human nose even at some distance from the plants. In a river valley at Ginumum Walk, Northern Territory, the sweet honey-like scent of some large individuals of *D. finlaysoniana* could be detected by myself even before I found the plants growing there. Interestingly the few large plants had captured a rich variety of large insect prey, almost exclusively consisting of medium-sized to large butterflies and moths (mainly diurnal, but also some apparently nocturnal species). Some individuals of *D. finlaysoniana* were literally covered in dead Lepidoptera (Figs. 2 & 3).

Figure 2: A single individual of strongly honey-perfumed *D. finlaysoniana* covered with prey. Besides Diptera (various small flies, midges and mosquitoes), Hymenoptera (small solitary wasps) and Thysanoptera (thrips), prey mainly consisted of Lepidoptera: 1. Geometridae (a species of geometer moth), 2. Pterophoridae (species of plume moth), 3. day-flying Tiger Moth (probably *Amata* sp.; Arctiidae), 4. Grass Yellow (*Eurema* sp., Pieridae), and 5. Eight individuals of *Acraea terpsicore* (Nymphalidae). The accompanying pink-flowered plant at the bottom is the glandular, annual *Stylidium adenophorum*.

On a single large plant I counted an astonishing total of 35 butterflies and moths adhering to the numerous gland-covered, thread-like leaves of the plant. Most impressive was not only the large number of butterflies caught by the plant, but the many different species (both males and females) of Lepidoptera from different families which were found attracted to and killed by *D. finlaysoniana*.

A few of them could be tentatively identified from the photographs (Fig. 2). Very common prey was the Tawny Coster (*Acraea terpsicore*; Lepidoptera: Nymphalidae), an invasive butterfly species from India which spreads widely in Northern Australia; frequently, three or more individuals of that species (mainly males, but also females) were caught by a single plant of *D. finlaysoniana* (Fig. 2).

Figure 3: Three individuals of day-flying Tiger Moth (Arctiidae – Ctenuchinae, probably *Amata* sp.; left: 2 males, right: female) sticking to *D. finlaysoniana* at Keep River NP.

I also observed this and other butterfly species (especially Grass Yellows—*Eurema* species; Pieridae) being caught as frequent prey by non-scented members of the *D. indica*-complex (e.g. *D. serpens* and odorless *D. finlaysoniana* populations). However, these captures were usually rather solitary, and never in such high numbers as in the perfumed plants. Greg Bourke (pers. comm.) has found (non-scented) *D. serpens* with good numbers of Grass Yellow butterflies near Mareeba, northern Queensland, but only as many as maybe six or seven on an individual plant. Like my observations reported here, his finding was made in July, late in the growing season. Greg assumes that the presence of butterfly prey might also be dependent on the season, and earlier in the rainy season might be before the peak for the butterflies. Greg reported to me large populations of *D. hartmeyerorum* (non-scented) and *D. fragrans* (scented) between Broome and Derby, northern Western Australia, early in the season with just a few individuals of butterflies caught per plant. Any comparative prey observations from such large non-scented *Drosera* populations late in the season (at the height of butterfly presence) would be very interesting. Greg (pers. comm.) made a good point that also the habitat for these *Drosera* species might impact the number of available butterflies, especially where the sundew plants are concentrated in seepage habitats beside creeks where the only available moisture for butterflies is present, and where the insects might be more easily "channeled" to the *Drosera* traps, than in large, open swampy areas. Yet, it was quite obvious in the sympatrically growing species, *D. fragrans* (scented) and *D. aquatica* (non-scented) which I observed in a rather open swampy spot near Darwin in July, that the former had conspicuously more butterfly prey than the latter.

So what does attract these flower-visiting insects to the sticky traps of these *Drosera* species? Both color and scent can be connected with floral reward for pollinating insects (Chittka & Thomson 2001). Although foraging butterflies are generally more visually attracted to the flowers that they visit, guidance by olfactory floral cues also plays an important role (especially for distance attraction), and their antennae are very sensitive and receptive to floral scents (Dudareva & Pichersky 2006). Thus it is quite likely that some butterflies and moths might also have been attracted to *D. finlaysoniana* by the plant's sweet honey-odor, but not so much by its coloration[1], as the yellowish-green sundew did not contrast much from the surrounding herbaceous vegetation during the dry season.

Once one individual of a certain butterfly or moth species is sticking to the *Drosera*, it is of course possible that it unintentionally will attract more individuals of the same species, males as well as females (especially male butterflies are generally very territorial, and will approach or attack any other males and females of the same species that come close). This intraspecific attraction

to the caught individuals might be caused both by visual stimuli and transmitted pheromones from the living prey, and might explain the high numbers of caught Lepidoptera. However then why only the honey-scented *D. finlaysoniana* – I'm almost tempted to call it "the Australian dewy-pine" in dependence on *Drosophyllum* – were fully covered in Lepidoptera, but not their odorless congeners? By the way, the phenomenon of "intraspecific prey attraction via caught but still alive prey" can also be observed in dark-winged fungus gnats (Diptera: Sciaridae) caught by yellow sticky traps (or likewise *Pinguicula* leaves) on the windowsill or in the greenhouse: a single female fungus gnat struggling on the sticky surface will usually soon attract a large number of males, which are then also caught nearby. Interestingly I have not found any published evidence about such observations, or similar reports from a comparable system of natural sticky trap: spider webs (but see Bjorkman-Chiswell *et al.* 2004 for the attraction of saprophagous insects to dead prey in sticky traps).

Interestingly, those few *Drosera* species which have scented leaves altogether have non-perfumed flowers. On the other hand, in those *Drosera* species that have perfumed flowers (see Fleischmann *et al.* 2007; Gibson 2013; Lowrie 2013), I could detect no evident odor from the leaves. Both are reasonable, to separate pollinators from prey, which will be either attracted to the traps or the flowers by visual signals or scent, or vice versa.

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# An equation for determining percentage of herbivory on *Pinguicula moranensis* – A correction

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Recently Alcalá *et al.* (2010) explored the potentially defensive function of sticky traps in *Pinguicula moranensis*. Specifically, the authors assessed the defensive role of glandular trichomes in the interaction between *P. moranensis* and its insect herbivores.

Alcalá *et al.* (2010) offered a unique digital photography tool and a method for determining the amount of herbivory. To create a baseline level of insect herbivory the authors developed an equation to determine the percentage of leaf herbivory. Unfortunately, the equation published in the article contained an error. The goal of this article is to offer a correction to the error.

Herbivory damage was defined as the percent of leaf area eaten by herbivores. A leaf was considered damaged when part of its lamina was missing, including holes or incomplete leaf margins. Using digital photography software, the authors calculated the actual leaf area for each plant. The authors estimated, taking into account leaf overlap, they were able to measure over 80% of the leaves of each plant.

The actual leaf area (ALA) was defined as the sum of the leaf area of the leaves. To estimate potential leaf area (PLA), using the software the leaf contours were drawn minus the spaces representing the damaged areas.

Specifically, Alcalá *et al.* defined leaf herbivory (LH) as:

$$LH = \frac{(PLA \quad ALA)}{PLA} \times 100$$

If the goal is to estimate the fractional amount of leaf area that is missing as a result of herbivory, the published equation would not produce an accurate number. Mathematically, in this equation the PLA in the denominator will cancel out the PLA in the numerator, leaving only the ALA. This would result in the percentage of leaf herbivory equal to actual leaf area multiplied by 100. Consequently, the percentage of leaf herbivory would be much greater than actual leaf area available.

To determine the area missing, or percentage of area missing in the leaf, the correct operand in the numerator should be a minus sign. The correct equation should read:

$$LH = \frac{(PLA - ALA)}{PLA} \times 100$$

A review of the journal's table of contents did not reveal any errata correcting this error. As the content and results of the article appear to be accurate, consistent, and reasonable, it is likely that this was a simple typographical error.

This minor error aside, the digital photographic analysis and the equation estimating leaf herbivory are useful tools, and should be considered by botanists working on carnivorous plants.

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# Field trip report: Hybrids at Old Dock Preserve, North Carolina

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Keywords: *Sarracenia*, field trip report, natural hybrids.

I awake to the blaring sound of my cell phone's alarm. It's 6:30 am and I am struggling to force myself awake after the exhausting heat and humidity we experienced the day before while hiking "million flava field." Spot Cullen is already awake and much too chipper for someone functioning on only six hours of sleep after a 36-hour flight and the airline losing nearly all of his luggage along the way. We get ready for our day, join our other group member, Daryt Frank, and "enjoy" some hotel breakfast of eggs, over-cooked turkey bacon, and make-your-own waffles. We then load the car and drive an hour to meet Brad Wilson and Rick McCarthy so we can tour our first location of the day in Columbus County, North Carolina (NC), the famous Old Dock Preserve owned by the North Carolina Nature Conservancy. They were kind enough to give us permission to visit the Preserve to photograph the plants. This location is known as the best natural population of *Sarracenia minor* remaining in NC. We are expecting to see *S. flava*, *S. purpurea* subsp. *venosa*, *S. minor*, and the hybrids *S.* × *catesbaei* (*flava* × *purpurea*) and *S.* × *swaniana* (*minor* × *purpurea*), as well as *Drosera intermedia*, *D. capillaris*, *Pinguicula caerulea*, and a few *Utricularia*. We meet Brad and Rick near the Green Swamp and I give them a quick rundown of all we are going to see and then drive the remaining half hour to our first location. We drive down dusty, sandy logging roads, struggling to keep the car straight as we progress to our destination. When we arrive and the dust settles we cover ourselves in sunscreen and bug spray. The mosquitoes from this location are infamous for causing pain, itching, and severe swelling in some cases. I once brought a friend to this site and by the time we left his eyes were nearly swollen shut from all of the mosquito bites. We walk past the locked gate and down the road until I find the unusually dry path into the savannah. The weeks leading up to this trip have been incredibly dry with very little rainfall. We immediately spot the mounds of *D. intermedia* in full bloom with lots of *S. flava* as we make our way through the overgrown wiregrass (*Aristida stricta*), bog myrtle (*Morella caroliniensis*), and inkberry holly (*Ilex glabra*). As I lead the way through the brush I'm on the lookout for the domed heads of *S. minor*, which indicate that the hybrids are nearby. I pass dozens of *S. purpurea* and *S. flava*, but no *S. minor*. Then I spot the first *S. minor* with pathetic looking pitchers from the *Exyra* moth larvae that plague pitcher plant bogs throughout the Southeastern U.S. I'm getting close! I continue onward for a few minutes passing many beautiful specimens along the way, but I'm looking for a specific patch of nearly a dozen *S.* × *swaniana* that is prime for photographing. I find the plants, take a few photos, and wait for Brad to set up so he can take photos of his own. While he sets up his tripod, I continue down the overgrown, nearly invisible path to see what I can find. I locate a few additional nice *S.* × *swaniana* to show the group and some great clumps of *S. minor*. Then I stumble upon one of the most exciting things I have ever found on any of my numerous plant expeditions.

I'm looking at a single plant of *S.* × *harperi*, the natural hybrid between *S. flava* and *S. minor* (Fig. 1), and only about a yard away is a complex hybrid involving all three *Sarracenia* species found at this site (Fig. 2). I call Brad over to confirm my identification of the plants and he agrees. We have found the first record of both of these hybrids in NC!

Based on the distribution of *S. minor* and *S. flava* in NC it would seem likely that one might be able to find this hybrid in any of the three counties in which they both reportedly occur, but this particular hybrid is extremely rare. As far as I can tell, neither of these plants has ever been recorded

Figure 1: *Sarracenia* × *harperi*, the natural hybrid between *S. flava* and *S. minor*, found at Old Dock Preserve.

in NC. One reason for this is because in NC, *S. minor* typically blooms two to four weeks later than *S. flava*. This leaves only a very small window for these species to hybridize. There are few resources that list *S.* × *harperi* as occurring in the state, but none have links to verified reports or herbarium specimens. I personally believe that many of these resources base this on the distribution of the species rather than confirmed reports. I have searched through the herbaria at many local institutions including NCSU and UNC-Chapel Hill for specimens of these hybrids from North Carolina but to no avail. And a search of online herbaria yields no results.

I actually photographed the same *S.* × *harperi* nearly two years ago on two separate occasions not knowing exactly what I was looking at. However, the complex hybrid I had never seen before despite the two plants being only a few feet apart. Even if someone has reported this hybrid from the state before, this is still a significant find because of the extreme rarity of these hybrids.

Figure 2: A complex hybrid involving *Sarracenia flava*, *S. minor*, and *S. purpurea* subsp. *venosa*.

# Growing high elevation tropicals: Building a chamber to accommodate cool growing tropicals, alpines, and species requiring cold dormancy

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Keywords: growth chamber, growing methods, cooling, photoperiod.

In addition to my love of Gesneriads, I've found myself intrigued by carnivorous plants, especially species that grow high in Southeast Asian cloud forests, where temperatures drop from the low 15°C's to occasional brief frost. Not only does the temperature drop occur, but humidity simultaneously rises to nearly 100%. Carnivorous plants are not the only plants that require cool drops in temperature for health and blooming. Some plants require seasonal temperature drops for a winter rest, still others require a temperature reduction to induce blooming. Orchids, flytraps, alpine gesneriads, rarer species, such as *Saintpaulia goetzeana*, *Sarmienta scandens*, and even some *Columnea*, are among the gesneriads that enjoy cooler nights than the typical household environment can provide.

I had always avoided obtaining any of the exotic and often pricey carnivorous plants I saw in books and online, because I was put off by the prospect of providing the humidity and temperature drops they require. Living in Maryland with hot summers and cold winters and with humidity in the teens, this is not the easiest place to grow these species without a specially designed greenhouse. Not provided with the nightly chill, some fail to thrive, at best, while many will actually perish, literally growing themselves to death. The plant is essentially kept at full metabolism, as if it were a human being, jogging perpetually on a treadmill. Its respiration is increased and it just exhausts itself. Since many of these species cost over $100 for a small start, they are not plants to experiment on.

I recently decided it simply couldn't be impossible to cool a small area and grow some of these lovelies. I knew there were all sorts of methods using water cooled radiators, adapted wine chillers, refrigerator innards, air conditioning units, and even the über simple replacing of frozen water bottles into a terrarium at night. I researched many options and met with frustration at their unsuitability for the average person, either being too hard to regulate, expensive, or otherwise not possible to use inside a home. It was actually months of research and participating in online discussions that finally gave me a viable idea.

Johnston Controls makes a digital thermostat, which is designed to turn a conventional chest freezer into a wine chiller, keeping the temperatures well above freezing. A chest freezer has the advantage of being easily lit, with traditional sized fixtures, being well insulated, and reasonably inexpensive (for those inclined to grow such pricey plants). The concerns with using a freezer were that it would be so well insulated that it would not sufficiently warm during the day or that it may exhaust itself by cycling on and off, multiple times per day. Deciding to give it a try, the freezer, Johnston Control, and 6 tube T5 fixture were purchased.

A lid was constructed from framed plexiglass and it was time to play!

First, I was disappointed that the thermostat gave one option for temperature setting and was not paired with a built in timer. This meant I would have to place the thermostat (the freezer plugs directly into the thermostat, which plugs into a power source) on a timer and manipulate the on/off periods to facilitate a nightly cooling and daily warming. Second, it became apparent that the

freezer, being so well insulated, would become an oven under the intense lighting required by the plants. The lid of the freezer was easily removed and replaced with the plexiglass lid and the experimentation began.

In my excitement, I plugged in the light, after setting the thermostat to cool the freezer to 13°C, from 12 pm until 6 am, with the intention that the light would allow for a gradual warming to the maximum day temperature — ideally between 24°-28°C, with below 26°C preferred. I started with the chamber/freezer at room temperature, plugged in the light and watched the temperature for an hour. The temperature only went up 1.7°C, so I thought I was safe to put one of my beloved carnivorous plants inside. Anxious to let it experience ideal conditions, with an appropriately cooled night, I placed the plant inside and went up for supper. About 3 hours passed and I went to check on the temperatures and noticed the plastic cup keeping the plant enclosed for humidity appeared melted! My nightmare was confirmed when the internal temperatures read 66°C and the once prized piece of my carnivorous menagerie, *Nepenthes hamata*, was reduced to brown mush. That's right, I steamed a $150.00 plant! I was not pleased, but pressed on.

It was obvious that the lack of programming options in the thermostat would not allow me to set an ideal daytime temperature, while achieving the ideal night temperature drop. I would have to have the freezer cycle on and off, while the light was on, in order to keep the growing chamber cool, but not too cool! It was a matter of a few days of tweaking and monitoring cycles of on time to keep the temperatures suitable. Of course, that wasn't made simple either, due to the fact that most timers run on 15-minute increments and these increments of time dropped the temperatures too low, creating undesirable temperature swings. Other timers that allow single minute increments of time only had 7 program cycles, so I had my work cut out for me. Using a digital timer, I perfected the on/off cycles to keep my daytime temperatures at no warmer than 28°C and no lower than 23°C, with a minimal amount of fluctuation.

It was after further consideration, I decided to use the multiple on and off cycles as an advantage and time my lights and nightly cooling to allow for a gradual nightly cooling and gradual daily warming, with a stable daytime high. I decided, since the freezer came with a built in shelf, I'd utilize a plastic tote filled with water to create a level surface and act as a stabilizer for the temperature. The temperatures were tweaked to utter perfection and even included the luxury of a very natural daily rise and nightly fall. The "night" cooling cycle begins at midnight and continues until noon. The light comes on at 10 am, so that when the freezer cycles off at 12 noon there has been a gradual rise in temperatures with a correspondingly gentle rise in plant metabolism. During the "day", the on/off cycles for cooling the chamber starts with the freezer turning on for 10 min at 2:15 pm. This prevents a fast rise in temperature and allows for a gradual temperature increase. Then every 2 hours thereafter, the freezer comes on for 12 minutes. The extra minutes account for the tendency for the temperature to rise more quickly the longer the lights are on, due to the freezer's insulating capacity. The final two "day" cooling cycles occur after the lights are off at 10 pm (10:01 pm-10:13 pm) and again from 11 pm-11:15 pm, to allow for a gradual reduction in temperature and plant metabolism. Even if the engineers of the world weren't forward thinking enough to build timers and thermostats that met my need, I was most certainly a GENIUS!

Next, I noticed the humidity would need to be addressed. Unlike a refrigerator, a freezer of this type has no circulating fans and does not dry out the air significantly. The humidity still needed to be increased, because young plants, smaller than 15 cm in diameter require RH above 90% and the humidity naturally raises in tandem with the nightly temperature drop , due to the descending clouds and fog of the cloud forest. This was worrisome, because small humidifiers generally only run for

Figure 1: Ultrasonic humidifier with shop vac hose inserted into the output.

Figure 2: Shop vac hose from the humidifier, placed through a hole drilled through the lid, for added humidity.

one full day, before needing to be refilled and I find that too much bother, as well as an impossibility, when traveling. Nevertheless, I purchased a 7.6 liter capacity ultrasonic humidifier (Fig. 1); having had experience with them for use with terrariums before. I purchased a vacuum cleaner hose, drilled a hole in the plexiglass freezer lid, placed the working end into the output of the humidifier and the end of the hose destined to fit onto the shop vacuum into the drilled hole and there it was — the start of the solution to desired humidity (Fig. 2).

Some other small improvements and tweaks were made, including placing the humidifier on a timer to run every hour for 30 min at night and for 15 min increments during the day, every 2 hours. I only need to fill the humidifier weekly and humidity is maintained above 90% at all times, with the chamber being filled with a very naturalistic fog, overnight and into the morning. Weather stripping was used on the bottom edge of the lid to provide a seal and a small USB fan was added for circulation, which runs at all times (Fig. 3). Finally, I cut down some lighting baffle to fit the internal dimensions of the chamber, ordered some plastic trays that fit, placed live sphagnum moss in the trays, placed the baffling, and then placed the individual plant reservoirs on top of the baffling. I utilize wick watering, where the plants are potted with a piece of acrylic yarn run through the pot and out the bottom. The dangling excess is placed in a container of water, usually a plastic food container with a hole cut in the lid. The reasoning for placing the moss under the baffling was to have a place to grow the moss, promote humidity, and have a place, shaded by the plants above, to grow plants needing lower light (Fig. 3). Currently in the chamber are several carnivorous plant species, ant plants, ant ferns (these are plants and ferns that have symbiotic relationships with ants), *Saintpaulia goetzeana*, and soon to be some orchids and *Sarmienta scandens*. Among the carnivorous species are *Nepenthes edwardsiana*, *N. attenboroughii*, *N. hamata*, *N. inermis*, *N. mikei*, *N. ventricosa*, *Utricularia reniformis*, and *Heliamphora pulchella*.

Figure 3: The completed chamber. A $4 USB fan circulates the air and prevents moisture accumulating on the foliage.

This was an interesting project and can easily be adapted to keep plants that are warm temperate species chilled, but not frozen, for dormancy, force orchids and bulbs into bloom, grow alpine species in warm areas, create warmer environments for desert plants, and even to augment husbandry of exotic reptile and amphibians. The downside to this project is that although my plants are slow growers, in 3-5 years I will either need a new set-up or several more freezers to accommodate their growth. By then, I hope to have a greenhouse with more cooling options available.


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Keywords: cultivar, *Sarracenia* 'Leigha Simone', *Utricularia* 'Brazilian Beauty'.

## *Utricularia* 'Brazilian Beauty'

Submitted: 13 December 2015

In 2010 I crossed several flowers of *Utricularia reniformis* and *U. nephrophylla*. The resulting seed was germinated with a single vigorous clone selected to grow. Although both species and the cultivar are somewhat variable, the plant selected showed morphology intermediate between both parents in leaf size and shape (Fig. 1) as well as flower size and shape (Front Cover).

The name Brazilian Beauty represents the location from which both parent species originate and the attractiveness of the cultivar.

—Greg Bourke • PO Box 3049 • Bilpin • NSW 2758 • Australia • greg.bourke@rbgsyd.nsw.gov.au

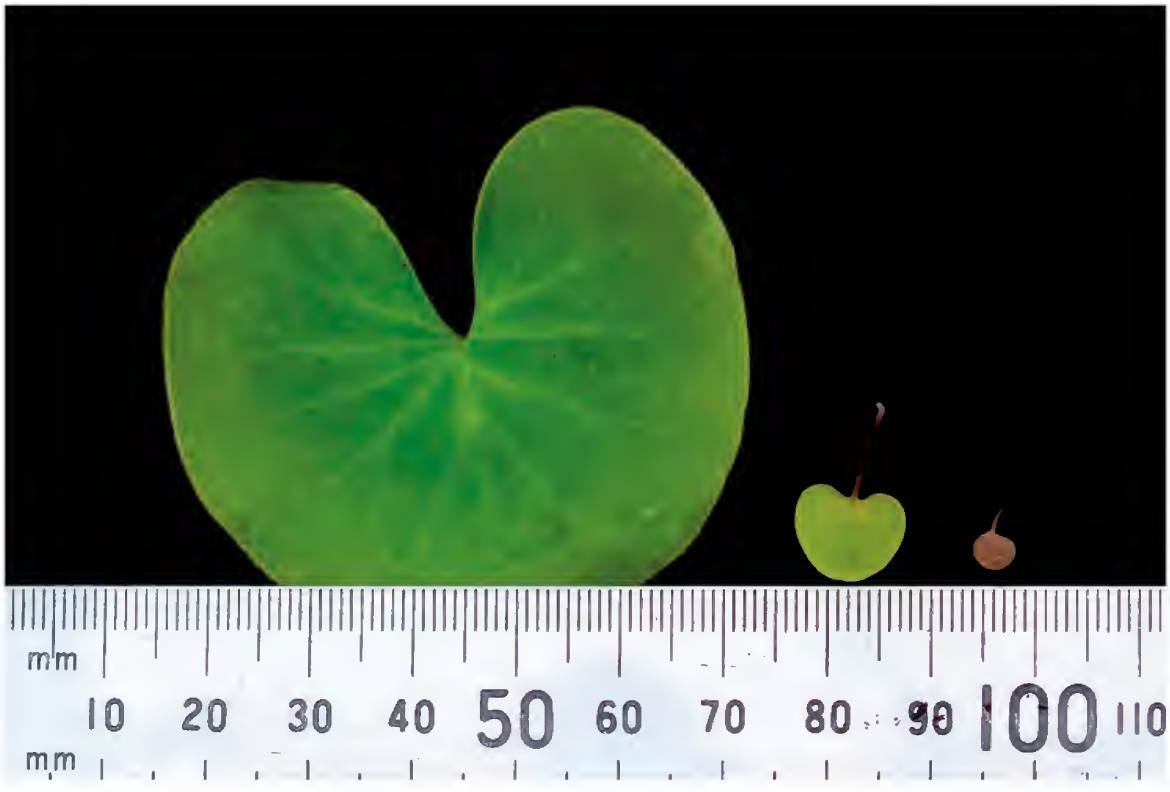


Figure 1: The leaves of *Utricularia reniformis*, *U.* 'Brazilian Beauty', and *U. nephrophylla* (left to right).

## *Sarracenia* 'Leigha Simone'

Submitted: 22 November 2015

*Sarracenia* 'Leigha Simone' is one of the plants from seeds that I germinated in 2011. I received the seeds from Olivier Bres from France, who crossed *S. leucophylla* (locally named purple and white giant form from Route 71, Altha, Florida) × *S. flava* var. *rubricorpora* (from Blackwater River State Park).

The first thing that caught my eye about this plant is its color. When the pitchers are just about to open, it is bright red with a very yellow hood (Fig. 2), just like a nice *S. flava* var. *rubricorpora*. When the pitchers open, they resemble a *S. flava* var. *rubricorpora* with a frilly spotted hood. The pitchers are about 75 cm tall with a thick tube, medium sized hood, and a thin peristome. As the pitchers age, they get thick and waxy looking and turn from a bright red to a purple/burgundy color with purplish/black veins and pinkish/white spots on the hood (Fig. 3). The flowers have reddish orange petals with a yellow tips (Fig. 2). The plant is a vigorous grower, dividing regularly and showing hybrid vigor.

This plant was named after my daughter. It should be reproduced only by vegetative means to ensure that its unique characteristics are maintained.

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Figure 2: New *Sarracenia* 'Leigha Simone' pitcher about to open (left) and flowers (right).

Figure 3: *Sarracenia* 'Leigha Simone' mature pitchers.

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